filter effect and the current magnetic field reduction, the simple Cu underlayer will be satisfactory. The alloy layer or the laminate film for the underlayer has additional two effects; one for magnetostriction control in ultra-thin free layers and the other for Hin control therein. Concretely, the following example is mentioned.

5 nanometer Ta/1 nm Ru/1.5 nm Cu/2 nm NiFe/0.5 nm CoFe/ 2 nm Cu/2.5 nm CoFe/0.9 nm Ru/2 nm CoFe/7 nm IrMn/5 nanometer Ta (7-2)

With the Ru underlayer of 1 nanometer thick, the film smoothness is improved, and with the spacer of 2 nanometers thick, Ms×t of the free layer could be 2.9 nanometer Tesla in terms of NiFe. Thus, even though the free layer is an ultra-thin layer, it readily realizes low Hin of around 10 Oe. Such low Hin is desirable, as the MR height dependence of the bias point is reduced. In addition, it is also desirable, as capable of realizing good bias point control even in the absence of any complicated thickness difference between the upper and lower pinned layers in the Synthetic AF. In the illustrated case (7-2), the Ru thickness is 1 nanometer, but is preferably from 0.5 nanometers to 5 nanometers, more preferably from 1 nanometers to 3 nanometers or so. The preferred thickness range could apply to other materials except Ru.

In the film (7-2), Hcu corresponds to the sum of the electrical shunt layers of Ru and Cu. For example, for Ru,

its specific resistance is 30 μΩcm and is about 3 times that of Cu. From the viewpoint of Hcu, the film (7-2) shall be equivalent to a film having a Cu thickness of 1.8 nanometers. However, from the viewpoint of MR, the resistance of Ru is high and shortens the mean free path for electrons. Therefore, if Ru is directly contacted with NiFe, the film structure could not almost exhibit a spin filter effect. Therefore, it is desirable that the layer to be contacted with the free layer is of a low-resistance material such as Cu, Au, Ag of the like. For Ru, it is desirable that it is contacted with the free layer via Cu, Au, Ag or the like in the form of a two-layered film. This is one reason why the underlayer is of a two-layered film.

In the illustrated case, the buffer layer of Ta is used. However, if the high conductance layer could exhibit the buffer effect by itself, the Ta layer will be not needed. For example, when a Zr layer is used in place of Ru, the Ta layer may be omitted.

For the buffer layer, any of Ti, Zr, W, Cu, Hf, Mo or their alloys may be employed in place of Ta. The thickness of the buffer layer made of any of them preferably falls between 1 nanometer and 7 nanometers, more preferably 2 nanometers and 5 nanometers or so.

In the illustrated case, the AF film is of IrMn (Ir: 5 to 40 at.%). The IrMn film thickness preferably falls between 3 nanometers and 13 nanometers or so. The merits of

IrMn are that, since the IrMn film could exhibit good pinning capabilities even though thin, it is suitable to narrow gap heads for high-density recording, and that, as containing the noble metal, it could maintain high MR ratio even after thermal treatment. The antiferromagnetic film of FeMn as in Comparative Case 2 could not maintain high MR ratio after thermal treatment. The demerit of the antiferromagnetic film of FeMn is especially remarkable in ultra-thin free layers such as those in the invention.

As the antiferromagnetic film, also employable is any of CrMn, NiMn and NiO. However, for realizing high MR ratio, AF films containing a noble metal are preferred. For example, in place of Ir, employable is Pd, Rh or the like. As compared with FeMn and NiMn films, the noble metal-containing AF films are more effective for improving MR ratio, and therefore could maintain high MR ratio even after annealing thermal treatment that is indispensable to heads. Still another preferred example of the materials for AF films is PtMn of which the noble metal content is much higher.

5 nanometer Ta/x nm Cu/2 nm NiFe/0.5 nm CoFe/2 nm Cu/2.5 nm CoFe/0.9 nm Ru/2 nm CoFe/10 nm PtMn/5 nanometer Ta

(7-3)

5 nanometer Ta/x nm Ru/y nm Cu/2 nm NiFe/0.5 nm CoFe/2 nm Cu/2.5 nm CoFe/0.9 nm Ru/2 nm CoFe/10 nm PtMn/5 nanometer Ta (7-4)

Using PtMn (Pt: 40 to 65 at.%) is advantageous in that,